STATUS OF THE DOUBLE-CRESTED CORMORANT IN BRITISH COLUMBIA

by
Ian E. Moul[1]
and
Martin B. Gebauer[2]

B.C. Ministry of Water, Land and Air Protection
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[1]Ian E. Moul
Foul Bay Ecological Research Ltd.
Box 28 Manson's Landing
Cortes Island, BC V0P 1K0

[2]Martin B. Gebauer
Gebauer & Associates
12634 28th Avenue
Surrey, BC, V4A 2P3

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FOREWORD

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ABSTRACT

The Double-crested Cormorant (*Phalacrocorax auritus*) is a large, black waterbird occurring primarily in marine areas of the Strait of Georgia and Juan de Fuca Strait. Two subspecies occur within the province: *P.a. albociliatus* breeds in the Strait of Georgia and Juan de Fuca Strait and is resident year round; *P.a. cincinatus* breeds in the Aleutian Islands through to south-western Alaska and winters south to British Columbia. It is possible that the breeding colony at Stum Lake, in central British Columbia, may be of the central Canadian population of *P.a. auritus*.

The Double-crested Cormorant in British Columbia nests primarily on the ground, although tree-nesting occurs at some sites. Bare, rocky islands with sparse vegetation are the preferred nesting habitats. Although large colonies have been reported in the past (e.g., 1100 active nests at Mandarte Island in 1983; 686 at Great Chain Island in 1990), current colony sizes are much smaller (e.g., 215 active nests at Mandarte Island and 104 at Great Chain Island in 2000). Cormorants forage in all coastal areas of British Columbia, utilising marine habitats such as bays, estuaries, and inlets and occasionally freshwater habitats such as lakes close to coastal areas and large rivers such as the Fraser River.

The Double-crested Cormorant was placed on the Conservation Data Centre's Red List in 2001 and is considered "Threatened." It was considered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to be "Not at Risk" in 1978, although, the status of separate subspecies was not assessed. The rapidly declining breeding population of the Double-crested Cormorant in the province is of concern. Increased Bald Eagle (*Haliaeetus leucocephalus*) and human disturbance appear to be negatively impacting breeding populations. Cormorants are impacted by eagles either directly (i.e., depredation) or indirectly when they are flushed from nests leaving eggs and chicks vulnerable to crow and gull depredation. Contaminant levels have declined in coastal areas and are not currently considered to be a major threat to cormorants. Given the rapid decline of cormorant breeding populations in British Columbia and their vulnerability to increasing human and eagle disturbance, this report recommends that the Double-crested Cormorant's Red-listed (i.e., Threatened) status be maintained.

In many other areas of North America, Double-crested Cormorant population levels have increased so dramatically that efforts are now being made to manage and control breeding and wintering populations. However, the apparent decline in the *P.a. albociliatus* subspecies in British Columbia calls for a different set of management actions. Management options include: a) establishing buffer zones around existing nesting colonies within which no unauthorised human activity is permitted; b) if colony visits are necessary, visiting should occur only during the late-nesting phase; and c) establishing protected areas on key rocks and islands used for breeding and roosting.

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1. INTRODUCTION

The Double-crested Cormorant (*Phalacrocorax auritus*) is found throughout much of North America, from the Canadian prairies south to Mexico, on the east coast from Newfoundland south to the islands of the Caribbean, and on the west coast from Alaska to central Mexico (Hatch and Weseloh 1999). In British Columbia, Double-crested Cormorants may be seen throughout coastal areas of the province and occasionally in the interior. Breeding colonies are found in only two areas: the Strait of Georgia (Campbell et al. 1990) and at one isolated interior colony on Stum Lake (J. Steciw, pers. comm.). According to an analysis of Breeding Bird Survey data, the North America-wide Double-crested Cormorant population has been increasing since records began in 1966 (Breeding Bird Surveys 1999). In British Columbia, from the earliest comprehensive count of 203 nests in 1959 (Drent and Guiguet 1961), the population increased to a maximum of 1981 breeding pairs in 1987 (Vermeer et al. 1989) but has fallen to 602 breeding pairs in 2000 (Chatwin et al. 2001).

The purpose of this report is to synthesise information relevant to Double-crested Cormorant populations occurring within British Columbia. An overview of information on their biology, habitat requirements, distribution, limiting factors and status is provided. Information was gathered from local naturalists, government biologists, published literature, and unpublished reports. The primary objective of this report is to determine the status of the Double-crested Cormorant in the province and to make recommendations to ensure that viable breeding and wintering populations remain in the future. This report is part of an ongoing program of the British Columbia Ministry of Water, Land and Air Protection, Biodiversity Branch, to more effectively manage species-at-risk for long-term population viability. Funding for this project was provided through the Nestucca Oil Spill Damage Trust Fund.

2. TAXONOMY

Of the 27 or 28 species of cormorants and shags that occur worldwide (Harrison 1983), six species are found in North America: Great (*Phalacrocorax carbo*), Double-crested, Pelagic (*P. pelagicus*), Brandt's (*P. penicillatus*), Red-faced (*P. urile*), and Olivaceous or Neotropic (*P. olivaceus*). The Double-crested Cormorant is considered to be most closely related to the Neotropic Cormorant (Hatch and Weseloh 1999).

Hatch and Weseloh (1999) describe five subspecies of Double-crested Cormorant, although Palmer (1962) recognises only four subspecies. The subspecies *P.a. auritus*, is the most widespread, being found across most of eastern and central North America, including the Canadian prairies, Great Lakes and maritime regions south to Louisiana and Texas (Palmer 1962). This subspecies is largely migratory, wintering on the eastern coast of the United States to the Gulf of Mexico (Howell and Webb 1995; Hatch and Weseloh 1999). The subspecies *P.a. floridanus* is resident in Florida and most of the Caribbean, whereas *P.a. heuretus* is resident only on San Salvador Island and possibly other islands of the Bahamas and Cuba (Hatch and Weseloh 1999; Watson et al. 1991 and Garrido and Kirkconnell 1992, as cited in Hatch and Weseloh 1999). The subspecies that breeds in British Columbia, *P.a. albociliatus*, breeds along the Pacific Coast from British Columbia to Baja, California, and inland possibly to New Mexico, Utah, Montana, and Sinaloa, Mexico (Howell and Webb 1995; Hatch and Weseloh 1999). The subspecies *P.a. cincinatus*, breeds in the Aleutian Islands through to south-western Alaska and winters south to British Columbia (Palmer 1962; Cannings 1998; Hatch and Weseloh 1999).

A disjunct inland colony breeds at Stum Lake in central British Columbia (J. Steciw, Ministry of Water, Land and Air Protection, pers. comm.). While no genetic testing or close examination has confirmed the subspecies of the Stum Lake cormorants, it has been postulated that they could be *P.a. auritus*, which is known to nest as close as central Alberta (Cannings 1998; Fraser et al 1999). While it is conceivable that birds in this colony may be of the central Canadian population of *P.a. auritus*, (Cannings1998), until studies are conducted to determine their taxonomy, they should be considered to be *P.a. albociliatus*.

3. GENERAL BIOLOGY

3.1 Reproductive Capability

3.1.1 Clutch size

Double-crested Cormorant clutches in British Columbia range in size from one to 11 eggs, with 96% of nests containing one to four eggs (van Tets 1959, as cited in Campbell et al. 1990; Campbell et al. 1990). Stenzel et al. (1995) noted that Double-crested Cormorants normally lay three to four eggs, rarely five or more.

Sullivan (1998) found that clutch size varied significantly between colonies in the Strait of Georgia. The mean clutch size on Mandarte Island was significantly higher (3.8 eggs in 1993) compared to 3.3 eggs per clutch at the other colonies in his study. Clutch size on Mandarte Island in 1993 was similar to that observed in 1970 (3.9 eggs) by Robertson (1971).

3.1.2 Incubation and fledgling periods

Ehrlich et al. (1988) describes the incubation period as ranging from 25 to 29 days and the fledgling period from 25 to 42 days. At Mandarte Island, 15 of 27 nests monitored by van Tets (1959; as cited in Campbell et al. 1990) had an incubation period of 27 or 28 days. Robertson (1971) found a similar incubation period of 25 to 28 days at Mandarte Island. However, the fledgling period of 50 to 55 days was considerably longer than reported by Ehrlich et al. (1988). Nestlings typically fledge between three or four weeks of age but are not able to fly for an additional two or three weeks (Hatch and Weseloh 1999).

Leger and McNeil (1985) reported that both parents attend the eggs and chicks, with nest attendance being 100% for the first three to four weeks following hatching. From four to six weeks, nest attendance is 90%, after which attendance drops off to feeding times only. No significant difference between male and female times and roles at the nest was observed.

3.1.3 Timing of reproductive periods

Within the Strait of Georgia, Double-crested Cormorants arrive at breeding colonies in early April (Drent et al. 1964). Campbell et al. (1990) reported that laying dates for 3628 clutches ranged from 20 April to 2 September, with 54% recorded between 22 June and 10 July. Sullivan (1998) found that mean egg-laying dates on Five Fingers Island were 10 May in 1993 and 22 May in 1994, compared to 25 June on Mandarte Island in 1993 and 9 August and 25 July on the Fraser River in 1993 and 1994, respectively.

Campbell et al. (1990) report that 1183 broods ranged from 10 June to 14 September, with 68% occurring between 10 July and 15 August. These dates likely encompass both nesting and flightless fledgling stages.

3.1.4 Reproductive success

Hatch and Weseloh (1999) noted that hatching success of cormorants is typically 50 to 75%, and fledgling success of the eggs that hatched was approximately 74 to 95%. Van der Veen (1973) observed a hatching success of 83.5% in birds from Mandarte Island in 1972 and estimated mean annual reproductive success of two young per nest. Drent et al. (1964) found hatching success of birds at Mandarte Island to be 60%, with an annual reproductive success of 2.5 young per nest. For Mandarte Island, van der Veen (1973) estimated average lifetime production of an adult as 3.3 young.

Brood size of Double-crested Cormorants in British Columbia ranged from one to eight, with 97% having one to three young (Campbell et al. 1990). Hunt and Evans (1997) found that the last-hatched chick in four chick broods never survived more than 12 days where all three elder siblings were still alive. Because older and larger siblings had better access to the parent, the primary cause of death of the fourth hatchling was competition between chicks for food. Stenzel et al. (1995), however, found successful fledgling of all four chicks in several nests at a colony in San Francisco Bay, suggesting that reproductive success may vary between places and years and is dependent on food availability.

When Robertson (1971) increased normal-sized broods (i.e., one to four chicks) by adding extra chicks up to a maximum of eight chicks per nest, he found that in broods of up to six chicks, fledgling success

was 90% or higher. Although up to seven chicks were fledged in some nests, growth rates were lower in supernormal broods, resulting in a fledgling period that was longer by several days. One brood of eight chicks had fledgling weights of some 500 to 800 grams below the normal weight, presumably because of the parents' difficulty in providing sufficient food for all chicks. Robertson (1971) concluded that broods greater than six appear to offer little reproductive advantage to cormorants.

Sullivan (1998) found that nestlings produced early in the season were heavier, had a slower growth rate and required more time to achieve their final mass than those produced later in the season.

3.1.5 Breeding frequency

Drent et al. (1964) suggest that some pairs may attempt to raise two broods per season. Some anecdotal information from Mandarte Island also supports this notion (I. Robertson, pers. comm.). However, many of the apparent double-brooding attempts may simply have been replacement clutches.

3.1.6 Solitary or colonial breeder

The vast majority of Double-crested Cormorants nest in colonies (Campbell et al. 1990; Hatch and Weseloh 1999). Exceptions include a single nest on a marine navigation marker approximately 500 m south of the main colony at Crofton (Moul, pers. obs.), and a single nest located on a piling in the Fraser River, 30 km inland, near the Port Mann Bridge (Campbell and Gibbard 1984).

3.2 Recruitment

Robertson (1971) found that returns of yearling Double-crested Cormorants to Mandarte Island in 1970 indicated a post-fledgling mortality of approximately 50%. Van der Veen (1973) determined the mortality rate of adult Double-crested Cormorants to be 15% per year, resulting in an average life expectancy of 6.2 years. Records from files of the Fish and Wildlife Service in the United States, as reported by Palmer (1962), indicate that annual mortality after the first year is about 22-26%.

Palmer (1962) noted that Double-crested Cormorants usually breed for the first time at three years of age, and that approximately 25% of cormorants at breeding colonies are non-breeders. In British Columbia, van der Veen (1973) calculated the mean age at first breeding to be 2.74 years. Approximately 4.7 % of birds appeared to breed first at one year, 16.5% at two years and 78.8% in their third year.

3.3 Nest Structure and Composition

Campbell et al. (1990), report that nests in British Columbia "ranged from sparse collections of twigs and seaweed to elaborate structures of sticks, well-lined with grasses, seaweed, rootlets, feathers, and assorted marine debris including rope, plastic bags, fishing lures, and paper." Most nests are lined with finer materials, and some twig and tree nests may have green leaves (Ehrlich et al. 1988). As the breeding season progresses, most nests become heavily coated with excrement. The largest nest in British Columbia was 0.9 m high and 0.7 m across (Campbell et al. 1990).

In the spring, male cormorants reclaim previously used nests not destroyed by winter storms (Lewis 1929; Siegel-Causey and Hunt 1986). Unused nests are dismantled and incorporated into new or active nests.

3.4 Movement Patterns

3.4.1 Seasonal migration

Seasonal migration is variable among the subspecies, and very little has been documented. Subspecies in the interior and the east coast of North America and in Alaska appear to move south in the winter (Hatch and Weseloh 1999). On the Pacific coast, particularly in the Georgia Basin, numbers of Double-crested Cormorants counted in the winter suggest that locally breeding birds remain year round (Moul 1996). Morgan (1989) found that Double-crested Cormorant populations within Saanich Inlet remained relatively consistent throughout the year, compared to Pelagic Cormorants, which exhibited obvious population peaks in the winter. In Jervis Inlet, Double-crested and Pelagic cormorants were most common between October and May (Vermeer 1989). It is likely that

migrants of the *P.a. cincinatus* subspecies from Alaska supplement these resident winter populations of *P.a. albociliatus* (Campbell et al. 1990; Johnsgard 1993; Cannings 1998).

Between late summer 1994 and the spring of 1996, Moul (1996) used implanted radio transmitters to track the movements of six adult Double-crested Cormorants, three from Mandarte Island and three from Great Chain Island. During the breeding season, all of the birds with radio transmitters returned to colonies where they had been captured and tagged. Two of the Mandarte Island birds stayed within the colony and Gulf Island area (a radius of 20 km) for the duration of the study. The remaining Mandarte Island bird was located each winter on the east shore of the Strait of Georgia near Tsawwassen. Of the Great Chain Island birds, one stayed in the vicinity of the colony for two years, the other two disappeared each winter. Birds banded in British Columbia have been encountered south as far as southern California (Hatch and Weseloh 1999).

Spring movements of the Double-crested Cormorant in coastal British Columbia occur between mid-March and late May but are most pronounced in late April and early May (Campbell et al. 1990). In autumn, migrating birds are evident between late August and early November. Most of the migrating birds are likely of the *P.a. cincinatus* subspecies, with movements most evident along the outer coast. Most birds of the *P.a. albociliatus* subspecies appear to remain within British Columbia waters; however, the birds are widely distributed, and movement patterns are poorly known.

3.4.2 Diurnal movements

During winter in British Columbia, Double-crested Cormorants move from the near coastal waters to more protected roost sites. While radio-tagged birds in British Columbia were not tracked for diurnal movement patterns, several winter roost sites have been reported (see section 4.1.4). In a study of 59 cormorants fitted with radio transmitters, wintering in the Delta Region of Mississippi, birds flew an average of 15.7 km (range: 3.5 to 62 km) between their night roosts and the foraging location (Glahn and Stickley 1995, King et al. 1995). In Wisconsin, Custer and Bunck (1992) found that cormorants flew less than 3 km (range: <1-40 km) from their breeding colony to their first forage site.

3.4.3 Dispersal of young

Moul (1996) reports Double-crested Cormorants banded as chicks in British Columbia have shown up as far south as Oregon and California (8 of 352 returns). More locally, 100 of 352 returns were from the Puget Sound area, with 44 of them near Padilla Bay and the mouth of the Skagit River. Morgan (pers. comm.) has observed immature Double-crested Cormorants offshore, over 600 km from the nearest land.

3.4.4 Colony-site fidelity

Of six adult Double-crested Cormorants caught in nesting areas during the breeding season and implanted with radio transmitters, all returned the following spring to the colonies where they were caught and tagged (Moul 1996). One of the birds, from Mandarte Island returned the following spring to nest within 2 m of the nest where it had been originally caught. It was not clear if the five remaining birds showed any nest-site fidelity within the colony sites.

3.5 Food

3.5.1 Breeding season

Palmer (1962) reported that fish were the most important prey species for *P.a. albociliatus* in marine areas but that a few crustaceans and plant material were also taken. Species included Rough-backed Sculpin (*Chitonotus pugetensis*), sculpins (*Cottus asper*), stickleback, flounders, smelt, sardines, pipefish, shrimp (*Crangon* ssp.), other crustaceans (*Corpphium spinicorne*, *Spirontocaris*) and traces of eelgrass. Samples of pellets and regurgitations from cormorants at seven sites from Mandarte Island to the Gulf of California in the breeding season included 2722 individuals from 95 taxa, dominated by schooling fish that are normally found well above flat bottoms (Ainley et al. 1981).

Robertson (1974) found that gunnels (Family *Pholidae*) made up more than 50% by mass and 45% by number of the nestling diet. Shiner Perch

(*Cymatogaster aggregatta*) also made up a large part of the diet. Sullivan (1998) found that nestling cormorants at Mandarte Island, Five Finger Island and by the mouth of the Fraser River were fed almost the identical prey species, although prey composition differed dramatically. Species identified within the diet at these three colonies included Pacific Herring (*Clupea harengus*), Pacific Salmon (*Oncorhynchus* spp.), Threespine Stickleback (*Gasterosteus aculeatus*), Shiner Perch, Pacific Snake Prickleback (*Lumpenus saggitta*), gunnel, Pacific Sandlance (*Ammodytes hexapterus*), rockfish (*Sebastes* spp.), Pacific Staghorn Sculpin (*Leptocottus armatus*) and Starry Flounder (*Platichthys stellatus*).

3.5.2 Non-breeding season

Double-crested Cormorants often come into conflict with fish farms and hatcheries, particularly in the southern United States (Duffy 1995; Glahn and Stickley 1995; Glahn et al. 1995; Jackson and Jackson 1995). When not nesting, Double-crested Cormorants move to where the fish are being released. Numerous papers document this at catfish ponds in Mississippi and with salmon releases on the Columbia River (Glahn and Stickley 1995; Glahn et al. 1995; Mott and Boyd 1995).

In March and April of 1995, Curt Kraemer (pers. comm.) noted that on Lake Washington and in other areas east of Seattle, cormorants would arrive shortly after salmon and steelhead smolts were released. In one case, two or three Double-crested Cormorants were present on a lake during the release of the smolts, but within two days numbers had increased to 300. Kraemer has counted as many as 600 Double-crested Cormorants on Lake Washington in late April and early May.

Rueggeberg and Booth (1989), did not find cormorants to be a significant cause of fish mortality at aquaculture operations in coastal British Columbia. Cormorants were observed to prey on, or injure, larger fish but in relatively small numbers.

3.6 Causes of Mortality

3.6.1 Egg mortality

Sullivan (1998) found the most common cause of egg mortality at Mandarte Island was depredation by Glaucous-winged Gulls (*Larus glaucescens*) and Northwestern Crows (*Corvus caurinus*) following disturbance by humans or Bald Eagles (*Haliaeetus leucocephalus*). In 1993, the completion of clutches was delayed by 45 days because of disturbance and depredation, and in 1994, depredation pressure did not subside and there was almost a complete breeding failure. Moul (2000) noted a similar pattern at other colonies in the Strait of Georgia.

On Ile Gros Pelerin and Ile-aux-pommes in the Saint Lawrence estuary, Ellison and Cleary (1978) noted that Herring Gulls (*Larus argentatus*) are known to prey upon unattended Double-crested Cormorant eggs and young.

3.6.2 Chick mortality

Young birds may die from excess heat or cold due to disturbance of the colony and the absence of the adult birds at the nest. Flushing of adults from nests within the first two weeks of life may lead to significant mortality of young birds due to exposure to sun (Weseloh et al. 1995). Small chicks may die from such exposure within 11 minutes. When exposed to cold, nestlings become comatose at a body temperature of 16-19° C but recover upon warming; cooling to 11.5° C was fatal (Van Scheik 1985, as cited in Hatch and Weseloh 1999). Moul (pers. obs.) has observed Glaucous-winged Gulls consuming small cormorant chicks following a colony disturbance by a Bald Eagle.

3.6.3 Adult mortality

Wilson et al. (1995) summarises the following five reported cases of cormorant mortality in British Columbia.

- In November 1977, cormorants (no breakdown of species was reported) were among some 200 seabirds found dead offshore of the Queen Charlotte Islands. While specimens were examined for toxicology and disease, cause of death was undetermined.
- In March of 1986, an injured and sickly cormorant collected from Burrard Inlet appeared to have died because of PCB poisoning.
- In August of 1989, 12 Brandt's Cormorants were

among 123 dead seabirds found off Pacific Rim National Park on Vancouver Island, but cause of death was not determined.

- In September 1990, a cormorant exhibiting symptoms of leg paralysis was collected near Sooke. While Newcastle Disease was considered as a possible cause of death, no results were reported.
- In March of 1994, 30 Brandt's Cormorants were found dead in Pacific Rim National Park. The most probable cause of death was entanglement in a fishing net and drowning.

While Moul (pers. obs.) has received verbal reports from both the public and from government agents, in regards to cormorants being killed or persecuted by commercial fishers and the aquaculture industry, no official reports or case files were located.

3.7 Sensitivity to Depredation

Double-crested Cormorants appear to be very sensitive to depredation. On Great Chain Island, Mandarte Island, Hudson Rocks and Five-finger Island, Bald Eagles have been observed to fly into the vicinity of cormorant colonies, usually to prey upon gulls (Geisbrecht 2001; T. Sullivan, pers. comm.; I. Moul, pers. obs.). In response to the arrival of an eagle, the entire colonies of Glaucous-winged Gulls, Pelagic and Double-crested cormorants flush from their nests. Typically, the cormorants flock and fly in wide circles out over the water before returning to their nests. During this time, gulls, and occasionally crows, would return to the colony site much more quickly than the cormorants, enabling them to consume undefended cormorant eggs and/or chicks. Ground-nesting Double-crested Cormorants appeared to suffer more depredations than Pelagic Cormorants, possibly due to their more accessible nesting sites on low flat islands and flat areas at the cliff tops, as opposed to narrow ledges on steep cliff faces that the Pelagic Cormorants select (Moul, pers. obs.). The scenario above was observed to occur at least once each day and sometimes several times in a day until late June or early July. At Great Chain Island, on 27 July 1999, at a time when the Double-crested Cormorant colony would typically appear to be a black mass of several hundred Double-crested Cormorant chicks, Moul (2000) observed one adult and two juvenile Bald Eagles perched on Double-crested Cormorant nests. No Double-crested Cormorant chicks were observed, and approximately 100 adult Double-crested Cormorant were "rafted up" on the ocean surface some 200 m southwest of the island. In late July and August, eagles were observed at cormorant colonies less frequently, because by this time eagles would usually have dispersed from their nesting sites following fledging of the eagle chicks (Moul 1993).

3.8 Sensitivity to Human Disturbance

Double-crested Cormorants in ground nesting colonies appear to be very sensitive to human disturbance. Between 1991 and 1995 at most Double-crested Cormorant colony sites, yearly egg collections were made by the Canadian Wildlife Service toxic chemical monitoring program (Moul 1991, 1992, 1993, 1994, 1995). Egg collections were timed to be early in the breeding season and as early as possible in the day, with all effort made to minimise disturbance to the colonies. In no cases (aside from being in a blind) was it possible to be on shore and within visual range of a colony and not have all the birds flush. Even at night, cormorants were very sensitive to disturbance. During 1994 and 1995, Moul (1996) and Sullivan (1998) made colony visits in the middle of the night to band chicks. While most adults would flush to the nearby water, a small portion of adults would stay with the flightless chicks.

Human disturbance within colony sites has been reported. In July of 1999, a colony of approximately 100 Pelagic Cormorant nests on Henry Island in the United States, 7 km southeast of Mandarte Island suddenly abandoned their nests, reportedly in response to persons throwing sticks and rocks from above (Peter Hieberg, pers. comm.). In August of 1991, on McRae Island near Powell River, Clyde Burton observed a man and his son walking among the Pelagic Cormorant nests (Moul 1991). The cormorant chicks, aged one to five weeks, had been scared from their nests and were piled up in cracks and crevasses near the nesting area. Other authors have also noted that human presence in a colony resulted in adult birds flushing and exposing eggs and/or chicks to predators

and the elements (Kury and Gochfeld 1975; Ellison and Cleary 1978; DesGranges and Reed 1981).

While the authors have not observed disturbances caused by pleasure boaters, Sullivan, (pers. comm.) frequently observed Pelagic Cormorants at Mandarte Island flushing in apparent response to tour boats, powered pleasure craft and kayakers in close proximity to the cliff face. Vermeer and Rankin (1984) indicated that a colony at Rose Islets decreased in 1983 as a result of disturbance by pleasure boaters. More recently, Giesbrecht (2001) found no apparent link between tour boats stopping by Great Chain Island or Mandarte Island and disturbance of Double-crested Cormorants. Double-crested Cormorants that nest at the top of cliff faces appear less susceptible to disturbance by boaters than those that nest lower down on flatter islands, or than Pelagic Cormorants that nest lower on vertical cliff faces.

At the Apostle Island colony site in Lake Superior, Wisconsin, adult Double-crested Cormorants would flush, circle overhead and land on the water several hundred meters away when disturbed (Craven and Lev 1987). Once human activity at the colony ended, they were slow to return to the colony, leaving young unattended for 20 to 60 minutes. Cairns et al. (1998) found that the largest colony in north-eastern North America at Ram Rocks, Prince Edward Island, (4516 nests in 1995) abandoned after shooting and harassment of adults during the sensitive pre-laying period. Most birds appeared to move to Little Courtin Island, approximately 3 km from Ram Island during 1996. Nest counts on Little Courtin went from 424 nests in 1995 to 4525 in 1996. In 1997, Ram Island was re-colonised, presumably by birds from Little Courtin Island. The re-established colony contained 1738 nests, while the Little Courtin Island population fell to 1549 nests. Findholt (1988) noted human disturbance as being one of the most serious threats to Double-crested Cormorant breeding in Wyoming.

Double-crested Cormorants may also be disturbed due to the proximity of commercial activities. In May 1991, Moul (1991) observed a commercial fishing vessel tied to the pilings of the Crofton colony. No adults could be seen on the nests, and approximately 50 adults were observed calling and flying in circles around the colony site.

3.9 Adaptability to Sudden Environmental Change

Wilson (1991) observed that fewer Double-crested Cormorants nested on the outer coast during years dominated by El Niño oceanographic conditions. In Oregon, during the strong 1983 El Niño, fewer birds nested, followed by almost no breeding in 1984 and then similar numbers in 1985 to those prior to 1983 (Bayer 1986). It is possible that birds move to inner waters during El Niño years and afterwards move back to outer coast waters (Carter et al. 1995). In British Columbia, while links between longer oscillations (20+ years) in ocean temperature and El Niño events and cormorant nesting success have not been investigated, Bertram et al. (2001) reports significantly slower growth rates in Rhinoceros Auklet *(Cerorhinca monocerata)* and Cassin's Auklet (*Ptychoramphus aleutics*) chicks on Triangle Island during warmer-water El Niño years.

4. HABITAT

4.1 Habitat Description

4.1.1 Breeding

Although trees have been used for nesting (Vermeer et al. 1989; Campbell et al. 1990), most Double-crested Cormorant colonies in British Columbia are located on relatively flat ground, either on the tops of low islands (for example, Great Chain Island, Rose Islet and Five Fingers Island) or on cliff tops on more steep-faced islands (for example, Mandarte Island and Mitlenatch Island). Tree and ground nests are generally never found in the same colony (Ehrlich et al. 1988), though at Crofton in 1993, 23 nests were built in a small stand of Douglas fir on Shoal Island, approximately 200 m south-west of the main colony site (Moul 1993). A colony at the base of a cliff at Bare Point, Chemainus, was located in trees, as was the small colony on the Ballingal Islets (Campbell et al. 1990). Nests have also been observed on pilings, navigation markers and other man-made structures. Of 1981 nests surveyed by Vermeer et al. (1989), 89% were on the ground, 10% were on pilings and navigation markers and just over 1% (or 25 nests) were in trees. In California, cormorants nested successfully (424 nests in 1990) on

the Richmond-San Rafael Bridge in the San Francisco Estuary (Stenzel et al. 1995).

Double-crested Cormorants frequently nest in close proximity to Pelagic Cormorants. Vermeer et al. (1989) noted that Pelagic Cormorants nested on significantly narrower ledges on cliff faces, closer to shore and lower above the water than Double-crested Cormorants. Pelagic Cormorants generally occupied the narrow ledges on cliff faces, whereas Double-crested Cormorants nested on the tops of cliffs.

Double-crested Cormorants are known to nest at one inland colony, along with American White Pelicans and Herring Gulls, at Stum Lake in the Cariboo region of central British Columbia (J. Steciw, pers. comm.).

4.1.2 Summer foraging

Summer foraging areas are assumed to be in close proximity to primary breeding colonies. In the Strait of Georgia during the summer breeding season, no radio-tagged cormorants were located farther than 5 km from the breeding colonies (Moul 1996), although it should be noted that tracking daily movement patterns was not part of the exercise.

4.1.3 Non-breeding foraging

The Double-crested Cormorant can be found in all coastal areas of British Columbia, including around Vancouver Island and the Queen Charlotte Islands. Foraging Double-crested Cormorants occur in the highest numbers in the Strait of Georgia and Juan de Fuca Strait. Marine habitats such as bays, estuaries, and inlets are used most frequently, but foraging also occurs occasionally in freshwater habitats such as lakes close to coastal areas, and along larger rivers such as the Fraser River (Campbell et al. 1990).

4.1.4 Roosting

Man-made structures such as wharves, log booms, pilings and jetties are important roosting areas for Double-crested Cormorants, but small islets and dead trees are also used (Campbell et al. 1990).

Double-crested Cormorant winter nocturnal roost sites have not been systematically catalogued. During the winter and spring, outside of the nesting season, Moul (1996) repeatedly observed Double-crested Cormorants at four locations: 1) in a stand of tall conifers along the Gorge Waterway in Victoria; 2) in a stand of deciduous trees on a small island between Beaver and Elk Lakes in Saanich; 3) on a floating wooden platform in Quamichan Lake near Duncan; and 4) on a derelict crane along the south arm of the Fraser River in Delta. Winter roost sites have been reported along the shore of Naylor Bay, on the north shore of Mayne Island, facing into Active Pass (Karen Clark, pers. comm.), at Wallace Island and in Pedder Bay, Mechosin (T. Chatwin, pers. comm.).

4.1.5 Staging

Staging areas for migrating Double-crested Cormorants have not been well documented in British Columbia. Seasonal movements are most pronounced on the outer coast and probably involve the race *P.a. cincinatus* (Campbell et al. 1990). In the Strait of Georgia, an apparent influx of birds occurs in early September, but birds are generally widely distributed. Congregations occur here again in February and March, when Pacific Herring and Pacific Sand Lance are spawning (Campbell et al. 1990).

4.2 Habitat Distribution

All marine habitats of British Columbia have some suitability for Double-crested Cormorants. Double-crested Cormorants have been seen over 600 km offshore (K. Morgan pers. comm.) Based on Double-crested Cormorant occurrence, optimum breeding and wintering habitats are in the Strait of Georgia and Juan de Fuca Strait. A few birds occur each year in coastal areas of the Queen Charlottes, the north coast and the outer coast of Vancouver Island. Campbell et al. (1990) describes several interior records of non-breeding Double-crested Cormorants. Large lakes such as Osoyoos, Okanagan, Canim and Takla lakes are visited most frequently. The only interior breeding record for Double-crested Cormorants in B.C. is at Stum Lake, west of Williams Lake.

4.3 Trend in Quality and Quantity of Critical Habitat

Generally, habitats used by Double-crested Cormorants

in the Strait of Georgia have not been greatly altered, and the quantity of available habitat has not changed. The quality of the available habitat may be considered in terms of the impact of changes in the natural environment, or as a result of human activities. El Niño events in 1983 and 1992 and 1997 to 1998 may have lead to a reduction in local populations of forage-fish in coastal British Columbia, but data is scanty. High levels of contaminants such as PCBs, DDE, dioxins and furans in the 1970s and 1980s appear to have declined recently to levels of only minor concern in terms of habitat quality (Nichol et al. 2000).

4.4 Present Habitat Status

Because the majority of known Double-crested Cormorant colonies have lower nest numbers than were historically recorded, or have been abandoned, (see section 6.2.1), nest site habitat availability is not a limiting factor. Of greater concern is the lack of adequate protection on and around many of the smaller colony sites. While the landbase of several important breeding colonies of Double-crested Cormorant in coastal British Columbia is protected, others colonies are not (Table 1), and little protection exists for the marine areas around the colonies or for adjacent important foraging areas.

5. DISTRIBUTION

5.1 North America

5.1.1 Breeding season

The Pacific population of the Double-crested Cormorant (*P.a. albociliatus*) breeds between southern British Columbia and Sinaloa, Mexico (Howell and Webb 1995; Hatch and Weseloh 1999) (Figure 1). In British Columbia and northern Washington, it breeds in coastal areas, particularly in the protected waters of the Strait of Georgia and Juan de Fuca Strait. In southern Washington and Oregon, most birds breed in coastal areas, with smaller numbers inland along the lower Columbia River and northern Willamette River.

Table 1. Protected status of Double-crested Cormorant colonies in British Columbia.

Colony Name	Number of Nests (maximum recorded)	Land Title Status [1]
Great Chain Island	686	Ecological Reserve
Mandarte Island	1100	Indian Reserve – University research agreement
Ballingal Island	28	Provincial Nature Park
Rose Islets	80	Ecological Reserve
Channel Islands	16	Unknown
Galiano Cliffs	14	Islands Trust Fund
Canoe Island	12	Ecological Reserve
Second Sister Island	9	Unknown
Crofton/Shoal Island	104	Private property/Industrial
Bare Point	198	Private property/Industrial
Hudson Rocks	25	Government Reserve
Five Fingers Island	378	Government Reserve
Mitlenatch Island	70	Provincial Park
Sand Heads	86	Navigation marker
Westshore Terminal	52	Navigation marker
Queens Reach	1	Bridge
McRae Islets	1	Unknown
Christie Island	120	Bird Sanctuary
Merry Island	54	Unknown
Stum Lake	11	Provincial Park

[1] Ecological reserve status was derived from notations on 1:50,000 National Topographic System maps.

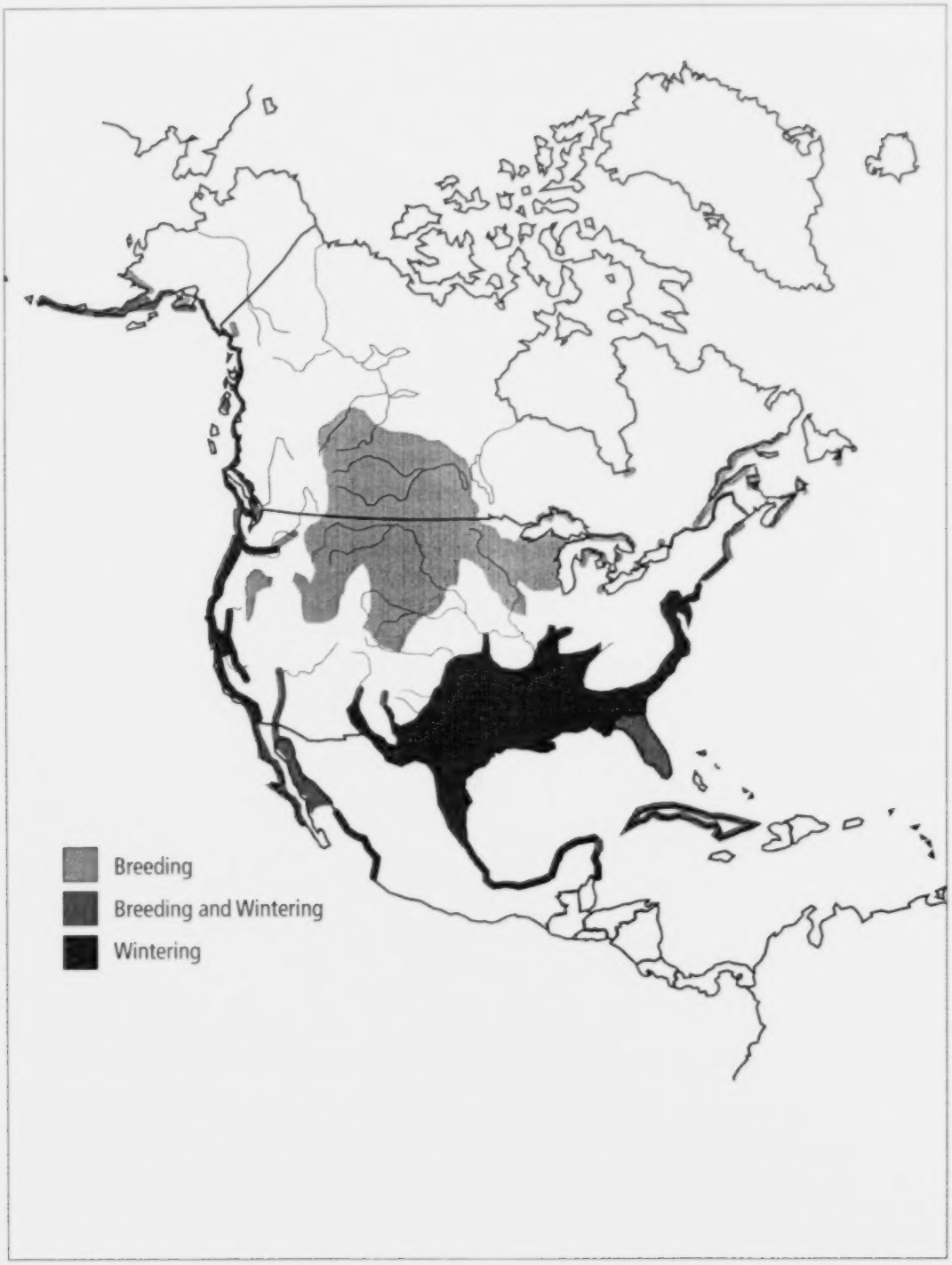

Figure 1. Breeding and non-breeding distribution of the Double-crested Cormorant in North America (from Hatch and Weseloh 1999).

Most birds in California also nest in coastal areas with some breeding concentrations inland in the Central Valley, lower Colorado River and Salton Sea. In Mexico, birds breed throughout coastal areas of Baja California and the Gulf of California and locally in inland areas (Howell and Webb 1995).

Other subspecies of Double-crested Cormorant are widespread in central and eastern areas of North America. The four other main breeding regions include: a) Alaska, particularly the Aleutian Islands; b) Canadian and U.S. interior, particularly in the prairie provinces and states; c) Atlantic Coast from Newfoundland to New York; and d) Florida and the western Caribbean.

5.1.2 Non-breeding season

Double-crested Cormorants on the Pacific Coast are largely resident and therefore winter throughout their summer range. In British Columbia, wintering birds likely include migrants from Alaska. Cormorants also winter inland along the Columbia River of Washington and Oregon, throughout coastal areas of Oregon and California, in the Central Valley of California and along the lower Colorado River (Howell and Webb 1995).

Interior and eastern populations of cormorants are strongly migratory, wintering in coastal areas from Northern Carolina to the western Gulf of Mexico (Hatch and Weseloh 1999). Birds also winter along the Gulf Coast of Mexico south to the Yucatan Peninsula and Belize (Howell and Webb 1995) and in the northern Caribbean Islands (Raffaele et al. 1998).

5.2 British Columbia

In British Columbia, Double-crested Cormorants are found primarily on the coast, though there are occasional sightings throughout the province to as far north in the interior as the Peace River area (Campbell et al. 1990). Closely associated with, and considered contiguous to the British Columbia population of Double-crested Cormorants, are those found in Washington State throughout Puget Sound and Juan de Fuca Strait.

5.2.1 Breeding season

Double-crested Cormorant breeding colonies are found on the coast in the vicinity of the Strait of Georgia (Figure 2) and at one isolated inland site at Stum Lake, west of Williams Lake in the interior. Double-crested Cormorants breeding on the coast are found primarily in the southern portions of the Strait of Georgia. The two largest colonies, Great Chain Island and Mandarte Island, are off southern Vancouver Island, and the third largest, Five Fingers Island, is off Nanaimo (Figure 2). Prior to 1993, no colonies were known to exist north of Nanaimo. In 1993, the breeding range extended some 150 km north to Mitlenatch Island at the northern limit of the Strait of Georgia. In Washington State, in waters proximate to British Columbia, Double-crested Cormorants nest in colonies at the south-western margins of Juan de Fuca Strait, on Smith Island and on Protection Island (Carter et al. 1995). Also in Washington State, Double-crested Cormorants historically (1970s and 1980s) nested at 14 sites on small rocky islands throughout the San Juan Islands (Carter et al. 1995). As of the 1990s, the San Juan colonies had largely been abandoned, and a new site on marine pilings at the mouth of the Snohomish River was colonised with approximately 100 nesting pairs (R. Millner, pers. comm.). More recently, between 1997 and 2000, there has been renewed cormorant nesting attempts on some of the smaller rocky islets throughout the San Juan Islands (U. Wilson, pers. comm.)

During the breeding season, non-breeding Double-crested Cormorants have been sighted in most areas of the coast, around Vancouver Island, around the Queen Charlotte Islands, and on the central and north coasts (Campbell et al. 1990). Non-breeding Double-crested Cormorants have also been seen throughout much of the central interior of the province as far north as lakes east of Smithers and around Dawson Creek.

Breeding at Stum Lake is a recent occurrence and was not reported at the lake in the late 1970s (Dunbar 1984). The first confirmed breeding record, by W. Campbell, J. Young and M. Chutter, was in late July 1993 (M. Chutter, pers. comm). The Stum Lake colony site appears to be an anomaly, though Double-crested Cormorants have often been recorded on freshwater lakes in B.C. (Campbell et al. 1990), and it is possible that additional undiscovered interior colonies may exist in the province.

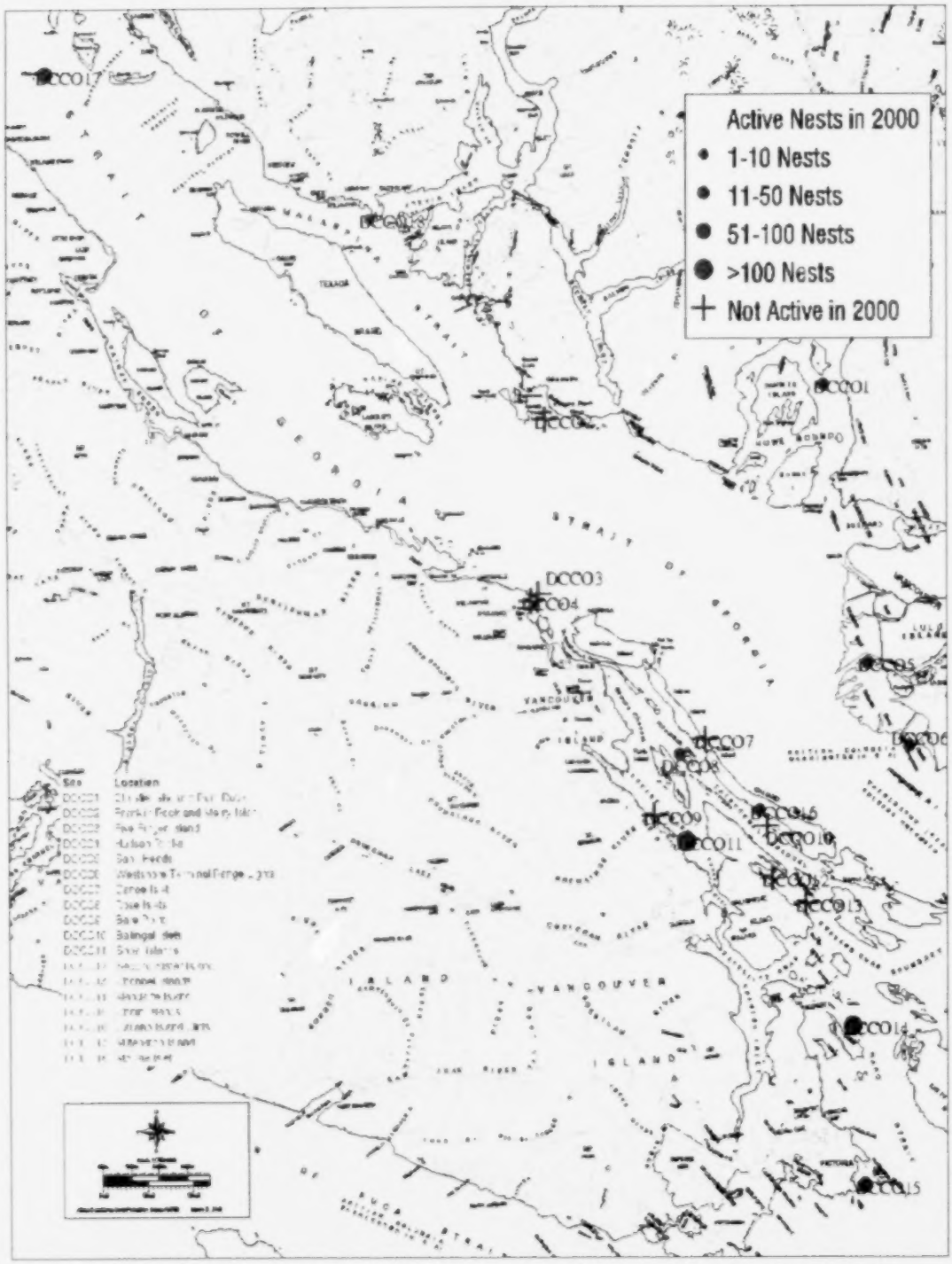

Figure 2. Current breeding distribution of Double-crested Cormorants around the Strait of Georgia, British Columbia.

5.2.2 Non-breeding season

During the non-breeding season, Double-crested Cormorants are found throughout coastal British Columbia, with sporadic sighting in the southern interior (Hatler et al. 1978; Campbell et al. 1990; Bird Studies Canada 2000). Given that the numbers of Double-crested Cormorants recorded during Christmas Bird Counts (see section 6.2.2) are well above the known numbers of local breeders, a large portion of the wintering Double-crested Cormorants are assumed to be migrants from either Alaska or the interior of the continent (Campbell et al. 1990; Cannings 1998).

6. POPULATION SIZE AND TRENDS

6.1 Population Size

Carter et al. (1995) estimated the Pacific coast population of *P.a. albociliatus* to be 49,094 birds (43,358 at 126 coastal colonies and at least 5736 at 22 interior colonies). There has been no attempt to take a complete census of the local population of Double-crested Cormorants (adults, sub-adults and fledglings) in the Strait of Georgia area. All efforts to census the local population of Double-crested Cormorants have been made by counting nests, with the assumption that each nest represents one breeding pair (Appendix 1).

Archaeological evidence shows the presence of Double-crested Cormorant at five sites in the Strait of Georgia during the period from 3500 BC to 1800 AD (Hobson and Driver 1989), but this evidence is based on adult bones and does not provide any answers on breeding status. The earliest known clearly documented nest records of Double-crested Cormorants within the Georgia Basin consisted of one active and two abandoned nests on Mandarte Island (reported as Bare Island) in 1927 by Munro (1928). At various colonies, additional nesting records were reported sporadically through the 1930s, 40s and 50s (see Appendix 1). The first comprehensive surveys and compilation of nest records totalling 203 nests was completed in 1959 by Drent and Guiguet (1961) (Table 2). Further comprehensive survey efforts carried out in 1974 and 1975 by Campbell (1976) documented 671 nests. In 1983, Vermeer and Rankin (1984) documented 1607 nests, and in 1987, Vermeer at al. (1989) reported 1981 nests. Through the 1990s, partial colony surveys were conducted by Breault (1990) and by Moul (1991, 1992, 1993, 1994, 1995 and 2000). These nest counts were not made at every known colony and were a by-product of the egg collections. The most recent effort to make a complete nest count at all known colony sites was in 2000 by Chatwin et al. (2001), who counted a total of 602 nests in the Strait of Georgia

6.2 Population Trends

Increases in Double-crested Cormorant populations have been noted in most areas of North America including eastern Canada, the prairie provinces and states, the Atlantic Coast, and the west coast (Chapdelaine and Bedard 1995; Hatch 1995; Breeding Bird Surveys 2000). These increases contrast sharply to the recent declines in breeding populations in coastal British Columbia (Carter et al. 1995). For British Columbia, the Breeding Bird Survey indicated the data as "unreliable," and the Canadian Bird Trend Data-base (1996) provides no information on Double-crested Cormorant breeding trends in British Columbia.

For Double-crested Cormorants nesting around the Strait of Georgia, there are two data sets available for attempting to draw population trends: nest census records carried out by various agencies between the 1950s and the year 2000 and Christmas Bird Counts. While this report is specific to British Columbia and the Canadian portion of the Georgia Basin area, some discussion of Double-crested Cormorant trends in Puget Sound and the San Juan Islands of Washington State is important for understanding the overall situation.

6.2.1 Nest counts

The available records of active nests counted indicate that the total population of known breeding pairs of Double-crested Cormorants in the Strait of Georgia increased from 203 in 1959 to a maximum of 1981 in 1987 and then declined by two-thirds to 602 nests in 2000 (Table 2) (Figure 3). Numbers of nests counted at the two historically largest colonies (Great Chain Island and Mandarte Island) combined for a total of 150 nests in 1959, rose to 1482 nests in 1987 and then

Table 2. Numbers of active nests counted at Double-crested Cormorant colonies in the Strait of Georgia, British Columbia, 1959 to 2000. Blank, or missing values indicate that no survey was conducted.

Colony name	Number of active nests										
	1959[1]	1974[2]	1983[3]	1987[4]	1990[5]	1993[6]	1994[7]	1995[8]	1998[9]	1999[0]	2000[10]
Great Chain Island	0	0	135	510	686	339	444	432	300	100	95
Mandarte Island	150	482	1100	972	473	458	403	288	178	43	215
Ballingal Island	28	14	20	25							0
Rose Islets	0	80	12	2						6	15
Channel Islands	16	0	0	0							0
Galiano Cliffs	0	0	0	0							14
Canoe Island	0	12	0	0							0
Second Sister Island	9	0	0	0							
Shoal Island	0	0	0	65	44	74	75	71		83	104
Bare Point	0	0	198	0	18				19	11	0
Hudson Rocks	0	0	0	17		25	16	15	0	0	0
Five Fingers Island	0	0	0	138	153	306	378	295	43	42	0
Mitlenatch Island	0	0	0	0	0	10	33	43	46	47	70
Sub-total Vancouver Island	203	588	1465	1729	1374	1212	1349	1144	586	332	513
Sand Heads	0	0	0	86							35
Westshore Terminal	0	0	0	42		52	26				11
Queen's Reach	0	0	1	0							
McRae Islets	0	0	0	0							1
Christie Island	0	29	120	119							42
Merry Island	0	54	21	5							0
Sub-total Lower Mainland	0	83	142	252	0	52	26	0	0	0	89
Total active nests	203	671	1607	1981	1374	1264	1375	1144	586	332	602

1. Drent and Guiguet (1961)
2. Campbell (1976)
3. Vermeer and Rankin (1984)
4. Vermeer et al. (1989)
5. Breault (1990)
6. Moul (1993)
7. Moul (1994)
8. Moul (1995)
9. Moul (2000)
10. Chatwin et al. (2001)

fell to 310 nests in 2000. Neither of these colonies showed a significant linear change in nest numbers over the 31 years data were collected at Mandarte Island and 17 years at Great Chain Island; however, nest numbers at both colonies had large fluctuations. Two smaller, more recent colonies at Crofton (Shoal Island) and Mitlenatch Island did show significant increases in nest numbers since they were first colonised (1987 and 1993) (Chatwin et al. 2001). Colonies in the Lower Mainland area had insufficient data to examine population trends statistically (Chatwin et al. 2001).

Carter et al. (1995) noted that declines of cormorant populations were occurring in British Columbia, Washington and Baja California. In contrast to these findings, Hatch (1995) noted that west coast populations in the United States and Canada (31,000 pairs in 1995, including Alaska) were increasing rapidly. It is possible that the factors causing declines in the smaller British Columbia populations are not as evident in Oregon and California.

When attempting to draw conclusions in regards to changes in a population it becomes very important to select the range of years to compare and also the area to sample. On the inland waters of Washington State, including Juan de Fuca Strait, the San Juan Islands and Puget Sound between 1993 and 2000, Wilson (Washington State Fish and Wildlife, unpub. data. 2001) reports a significant drop in numbers of active nests. Within this same area, sub-samples of nest counts from Protection and Smith Islands in Juan de Fuca Strait dropped in overall numbers, while at the same time numbers in the San Juan Islands increased. Overall, the trend appears to be a shift to the San Juan Islands from Smith Island and Protection Island. Just a few years earlier, between 1975 and 1992, Carter et al. (1995) reported an increasing trend in the Double-crested Cormorant population over the same area, with a shift from the San Juan Islands to Smith Island and Protection Island.

6.2.2 Christmas Bird Counts

Christmas Bird counts are conducted between mid-December and early January each year (Christmas Bird Count Data 2000). The counts represent the absolute number of birds counted within a 12-km radius circle centred at specific sites and surveyed each year. Christmas Bird Counts are an effective snapshot of selected locations across time and do not represent a total count of the wintering population. The

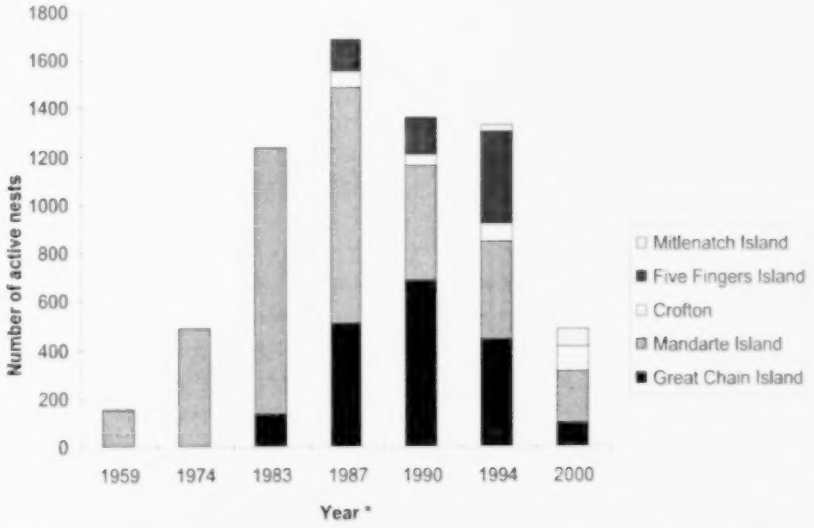

Figure 3. Numbers of Double-crested Cormorant nests counted around southern and eastern Vancouver Island, British Columbia, 1959 through 2000.
* Please note that the years are not evenly spaced.

website from which the data was obtained (Christmas Bird Count Data 2000) had a clear disclaimer in regards to using the data for scientific studies, and they are presented here for discussion purposes only. No effort has been made to extrapolate from the sample sites to the whole region, and no effort has been made to factor in effects of time, tide, weather or search effort, all of which will affect a count in any given year.

Within the circles represented, there appears to be no change in the Strait of Georgia Double-crested Cormorant wintering population between 1987 and 1999 (Table 3), whereas populations wintering in Puget Sound appear to be on a slightly upward trend (Table 4). In terms of the overall numbers of Double-crested Cormorants wintering in the Georgia Basin area, an average of 1500 birds was found in the Strait of Georgia, and 2.7 times as many, an average of 4000 birds, were counted in Puget Sound (Figure 4).

The wintering population most likely includes many Double-crested Cormorants that have migrated form other areas. To date it remains unknown if these represent Double-crested Cormorants from Alaska or from the interior regions of North America. Overall, Christmas bird count data suggest that the winter population of Double-crested Cormorants is stable and may not be influenced by factors that affect the summer breeding population.

7. LEGAL PROTECTION

The Double-crested Cormorant, its nests and eggs, are protected from destruction (i.e., hunting, egg-collection, etc.) in British Columbia by Section 34 of the British Columbia *Wildlife Act*. The Double-crested Cormorant is currently Red-listed by the Conservation Data Centre (CDC 2001).

8. LIMITING FACTORS

8.1 Availability of Foraging Areas

Foraging areas are readily available in the Strait of Georgia and Juan de Fuca Strait and do not appear to be a limiting factor. Shallow, protected foraging areas on the west coast of Vancouver Island, Queen Charlottes and the North Coast are much less available and may be limiting Double-crested Cormorant distribution in these areas. Forage-fish availability and abundance is also likely very different between outer coast habitats and the more protected inland coastal waters. While forage-fish may be available in urban

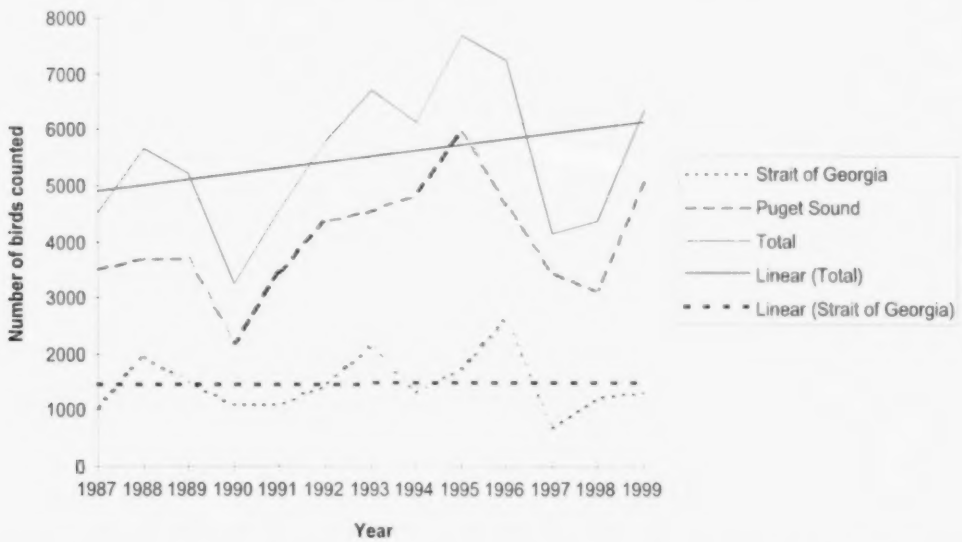

Figure 4. Total numbers of Double-crested Cormorants counted during Christmas Bird Counts from 1987 to 1999.

Table 3. Total numbers of Double-crested Cormorants counted on Christmas Bird Counts circles located in the south coast area of British Columbia.

Area	Number of Double-crested Cormorants counted each year												
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
South and south-east coast of Vancouver Island													
Pender Islands	38	86	55	78	59	89	128	98	525	50	66	75	290
Victoria	306	336	521	410	261	334	875	374	533	239	399	863	509
Sooke	214	162	183	153	169	243	290	NC	NC	191	NC	NC	254
Duncan	146	226	186	209	229	353	423	377	335	NC	NC	NC	NC
Nanaimo	216	1089	181	64	114	211	145	174	110	2072	58	160	122
Parksville-Qualicum Beach	NC	NC	NC	NC	19	69	39	44	101	31	27	26	12
Comox	35	5	59	32	18	53	64	63	18	NC	14	11	20
Campbell River	NC	NC	238	97	189	24	62	123	64	NC	99	68	72
Deep Bay	77	56	99	50	57	43	116	64	41	18	16	25	53
Sub-totals	1032	1960	1522	1093	1115	1419	2142	1317	1727	2601	679	1228	1332
Sunshine Coast and lower Fraser valley													
Chilliwack	0	0	1	2	1	0	4	2	7	12	1	2	1
Ladner	264	520	550	352	373	403	385	363	378	165	386	408	118
White Rock	142	148	94	6	99	104	185	165	121	177	211	193	167
Pender Harbour	NC	NC	NC	NC	90	90	58	111	98	51	102	77	112
Sunshine Coast	37	40	57	101	48	31	57	123	76	135	87	143	77
Pitt Meadows	0	8	4	11	17	0	27	37	11	13	26	NC	54
Squamish	10	22	16	12	33	NC	63	72	58	38	40	104	47
Vancouver	324	313	236	374	353	249	443	363	312	250	212	228	399
Sub-totals	777	1051	958	858	1014	877	1222	1236	1061	841	1065	1155	975
Totals	1809	3011	2480	1951	2129	2296	3364	2553	2553	3442	1744	2383	2307

NC = either no count was made, or no data on the count were available.

Table 4. Total numbers of Double-crested Cormorants counted on Christmas Bird Count circles located in the Georgia Basin area of British Columbia and Washington State.

Area	Number of Double-crested Cormorants counted each year												
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Bellingham	300	417	152	243	330	752	722	492	550	895	247	284	747
Edmonds	183	183	115	118	94	120	49	140	163	265	252	151	165
Kent-Auburn	32	67	48	70	56	118	78	94	98	215	61	118	70
Kitsap County	369	223	409	176	424	423	660	366	808	326	NC	NC	315
Oak Harbor	75	62	103	49	80	57	91	41	98	85	45	88	75
Olympia	557	689	345	252	313	469	580	638	1070	909	686	520	685
Padilla Bay	497	801	320	249	800	790	665	803	679	357	550	531	644
Port Townsend	38	59	41	32	55	79	158	124	72	NC	67	159	209
Skagit Bay	41	89	83	76	41	60	82	122	77	47	51	20	36
Sequim-Dungeness	123	62	54	NC	53	112	93	159	168	280	193	192	275
Seattle	409	429	581	NC	464	600	532	702	751	404	522	459	441
San Juan Islands Archipelago	483	308	956	181	125	156	269	406	328	184	0	53	455
Tacoma	397	322	482	731	609	634	588	741	1080	673	787	553	908
Sub-totals	3504	3711	3689	2177	3444	4370	4567	4828	5942	4640	3461	3128	5025
Sub-totals from B.C.	1809	3011	2480	1951	2129	2296	3364	2553	2553	3442	1744	2383	2307
Totals for B.C. and Washington	5313	6722	6169	4128	5573	6666	7931	7381	8730	8082	5205	5511	7332

NC = either no count was made, or no data on the count were available.

areas, such as the Gorge Waters in Victoria, the removal of roost trees, as discussed in section 8.3, could reduce the ability of cormorants to access the resource.

8.2 Availability of Nesting Habitat

Nesting habitat is readily available and does not appear to be limiting. Its acceptability depends on protection from harassment by eagles and human disturbance.

8.3 Habitat Loss

Habitat loss does not appear to be a significant limiting factor for cormorants. Other issues such as general encroachment and overall numbers of people in the area may be important factors.

8.3.1 Forestry

Forestry was an issue in 1999 when a log dump was proposed beside roost trees used by wintering Double-crested Cormorant on Mayne Island. Generally, cormorants in British Columbia nest on the ground and rarely in trees. Trees used for nesting are rarely of commercial value.

8.3.2 Urban development and recreation

Urban development in areas such as Vancouver, Victoria, and Nanaimo has lead to an increasing number of people pursuing recreational activities such as fishing and kayaking. These activities have lead to direct disturbance of cormorant colonies, resulting in increased egg and chick depredation from undefended nests by Glaucous-winged Gull. Recreational activity may also disturb roosting or perching Bald Eagles in the vicinity of cormorant colonies that can also lead to an increased frequency of disturbance. Long-term use of roost trees in urban areas can result in tree damage and foul odours; this has become an issue with some private land owners along the Gorge Waters in Greater Victoria where three commonly used roost trees were recently cut down by the land-owner due to concerns about the guano created by the birds (M. Chutter, pers. comm.).

8.4 Food Supply

Examination of the supply and quality of Double-crested Cormorant prey items has been carried out by Robertson (1971) and by Sullivan (1998). Because the bulk of the prey consumed by cormorants in the Georgia Basin area are non-commercial fish species, little effort has been made to track changes in the mix of fish species or their fluctuating abundance. There is some evidence that El Niño effects result in drastic changes to the abundance and availability of forage-fish in outer coast areas (Wilson 1991; Carter et al. 1995). Impacts of El Niño events in the interior water areas of Georgia Strait and Juan de Fuca Strait are not known. During conversations with numerous residents from the Gulf Islands and the eastern shore of Vancouver Island (Moul. pers. obs.), it has been speculated that over-harvest by commercial fisheries and a shift of primary herring spawning areas from the Gulf Islands and the Nanaimo area north to Baynes Sound near Denman Island may be contributing to changes in the numbers of nesting cormorants. To date, no published studies relating harvest practices to shifts in fish abundance have been located, and no clear correlation with shifts in cormorant distribution may be established.

8.5 Random Environmental Effects

Agler et al. (1999) found that fish-eating birds, including cormorants, declined by more than 50% in Prince William Sound, Alaska, between the early 1970s and early 1990s. Long-term fluctuations in the marine ecosystem may have caused changes in the forage-fish abundance of Prince William Sound, the Gulf of Alaska and other parts of the North Pacific Ocean (Piatt and Anderson 1996; Veit et al. 1996; and Francis et al. 1998, as cited in Agler et al. 1999). The declines in fish-eating birds in Prince William Sound apparently occurred before the 1989 Exxon Valdez oil spill, as evidenced by declines in other areas.

Carter et al. (1995) noted that changing trends in cormorant numbers on the Pacific Coast of North America were related in part to the El Niño effect. Wilson (1991) observed that few birds nested on the outer coast during years dominated by El Niño oceanographic conditions. In Oregon, during the

strong 1983 El Niño, fewer birds nested, followed by almost no breeding in 1984, and then similar numbers in 1985 to those prior to 1983 (Bayer 1986). It is possible that birds move to inner-coast waters during El Niño years and afterwards back to outer-coast waters (Carter et al. 1995).

8.6 Naturally Caused Depredation

Depredation by gulls and crows after disturbance by Bald Eagles appears to be the most serious limiting factor for breeding Double-crested Cormorants. Verbeek (1982) observed high depredation of cormorant eggs by Northwestern Crows on Mandarte Island between 1976 and 1980. Cormorants lost more eggs to crows when Bald Eagles were present than when they were not. On Five Fingers Island in 2000, River Otter *Lontra canadensis* were implicated in disturbance and depredation of nesting cormorants (Giesbrecht 2001). Cormorant colonies on Smith and Protection islands in Washington have been subjected to nest depredation by immature Bald Eagles that resulted in complete nesting failure from 1990 to 1992 (Carter et al. 1995). The sensitivity of cormorants to depredation has been previously discussed in more detail in Section 3.7.

8.7 Human Disturbance

Unintentional human disturbance (e.g., persons going ashore at colony sites and boaters in close proximity to cormorant nest sites) has been frequently cited as being detrimental to cormorant nesting success. Human disturbance at Mandarte Island resulted in cormorants leaving nests and increased depredation of eggs by Northwestern Crows (Verbeek 1982). In the St. Lawrence Estuary, frequent visits by investigators to colonies during the breeding season caused nest abandonment and gull depredation and discouraged late-nesting birds from settling (Ellison and Cleary 1978). Visits later in the breeding season, when chicks were partially grown, did not lead to the same level of nest abandonment. A Prince Edward Island colony, the largest in north-eastern North America (4517 nests in 1995), abandoned after apparent shooting and harassment of birds during the sensitive pre-laying period (Cairns et al. 1998). At the Bare Point colony in British Columbia, human disturbance from log-booming activities seems likely to have contributed to the decline from 792 birds in 1983 to 0, 50 and 36 birds in 1987, 1988 and 1990 respectively (Carter et al. 1995). More recently, on Great Chain Island, Mandarte Island and at Crofton, Giesbrecht (2001) observed no noticeable disturbance effect when tour boats and kayaks came to within 25 m of the shore.

Carter et al. (1995) described intentional harassment of cormorants by fisherman in Nehalem Bay, Oregon, because of the belief that birds were depleting hatchery-released salmon and steelhead. A recent Bill in the Oregon Legislature passed in August 1995 legalises harassment of all cormorant species in Tillamook County estuaries by declaring an emergency to protect salmon smolts. The sensitivity of cormorants to human disturbance has been previously discussed in more detail in Section 3.7. To date, only Pelagic and Brant's Cormorants have been reported as by-catch in commercial fishing gear in B.C. (K. Morgan, pers. comm.).

8.8 Environmental Contamination

Since 1970, Environment Canada has monitored chemical contamination at Double-crested Cormorant colonies by collecting egg samples. Sampling sites were at Great Chain Island, Mandarte Island, Crofton, Five Fingers Island, and by the mouth of the Fraser River.

Residue levels from Mandarte Island were reported in Nichol et al. (2000). Polychlorinated Biphenyls (PCBs) peaked at near 10 ppm in samples from 1973 and then fell to between 2 and 3 ppm through the 1990s. Dichloro-diphenyl-dichloroethylene (DDE) residues peaked in 1970 test results at 4 ppm and appear to have stabilised throughout the 1990s at less than 2 ppm. Dioxin and furan residue levels peaked in samples from 1985 at near 400 ppt then dropped to stabilise through the 1990s at less than 100 ppt.

Wilson et al. (1996) reports on contaminant levels in Double-crested Cormorants from the Fraser River estuary where total burdens of PCBs averaged 2.3 ppm in 1985 and 1988 and then fell to an average of 0.8 ppm from 1990 to 1992. DDE concentrations found in the Fraser River cormorants averaged 0.5 ppm in 1985 and

1988 and then fell to less than 0.22 ppm in 1990 to 1992. Total concentrations of dioxins and furans were higher in 1985 and 1988, 290 and 170 ppt respectively, and then fell to less than 52 ppt from 1990 to 1992.

In the waters of the northwest United States, Henny et al. (1989) reported residue levels from samples of Double-crested Cormorant eggs collected between 1977 and 1984 at colonies between the San Juan Islands and the Oregon coast. PCBs ranged from 1.27 to 6.76 ppm, and DDE ranged from 0.58 to 5.59 ppm. The PCB levels from Mandarte Island peaked higher, but stabilised within the range of those sampled by Henny et al. (1989). The DDE levels found on Mandarte Island were within the range reported by Henny et al. (1989).

Environmental contamination has been implicated in the large population declines of Double-crested Cormorants on the Great Lakes (Ludwig et al. 1995; Weseloh et al. 1995). High levels of metals, such as mercury and selenium, in cormorants in Florida (Sepulveda et al. 1998) indicate that birds in some regions may still be at the risk of poisoning leading to reproductive failure and possibly death. Eggshell thinning and its link with the pesticide DDT (as measured by its metabolite, DDE) has been documented in many bird species worldwide (Hickey and Anderson 1968). In the early 1970s, Gress et al. (1973) found that high levels of DDE led to excessive thinning of eggshells, with resulting reproductive failure. In 1984, Speich et al. (1992) measured shell thickness of a sample of Double-crested Cormorant eggs collected in Puget Sound and found no significant difference from eggshells collected pre-1947, before the widespread use of DDT. Given the similarity with the DDE residue levels measured in Puget Sound and on Mandarte Island, it is reasonable to assume that eggshell thinning has not played a part in the reduced nesting success observed on Mandarte Island.

High concentrations of PCBs and dioxins and furans are known to cause developmental deformities in Double-crested Cormorants (Gilbertson et al. 1991) from the Great Lakes. Laboratory studies of Double-crested Cormorant chicks hatched from eggs collected at Great Chain Island, Crofton and Christie Island, (Sanderson et al. 1994) had significant induction of enzyme activity, demonstrating a biological effect linked to contaminants, but specific links to successful fledging and survival of chicks were not examined. The most outwardly visible sign linked to chemical contamination is a crossed bill (Gilbertson et al. 1991). Crossed bills were observed in some Double-crested Cormorant chicks in British Columbia during 1989 (Breault 1990). During the 1990s, bill deformities were negligible on Mandarte Island (Nichol et al. 2000), though it is not clear if this is due to their absence or to a limited search effort.

Looking at the charts of PCB and DDE residue levels reported at Mandarte Island between 1970 and 1985 (Nichol et al. 2000), one might speculate a relationship between a rise in population with a fall in residue levels. Continuing on through the 1990s, a time with stable PCB and DDE residue levels and a drop in the breeding numbers of Double-crested Cormorants, there is no apparent correlation. A chart of dioxin and furan levels, also in Nichol et al. (2000), shows that the rise and fall of contaminant levels appears to closely track the numbers of breeding pairs. While no statistical analysis was reported in Nichol et al. (2000), even looking for a correlation between environmental contaminants and numbers of nesting cormorants in any given year has a major inherent problem. Given that Double-crested Cormorants are relatively long lived and may breed over several nesting seasons, it is possible that a rise or fall in contaminant levels may take a decade or more to show up in terms of numbers of nesting birds. A measure of nesting success directly correlated with residue levels in a sample of eggs from the same clutch may be a far more effective way to measure cause and effects of environmental contaminants. Increasing numbers of Double-crested Cormorants during times when contaminant levels were at a peak suggest that the contaminant levels detected were not adversely affecting the overall reproductive success in the Strait of Georgia (Wilson et al. 1996). The effect of environmental contaminants on the recent drop in the breeding population of Double-crested Cormorants is not clearly known.

Environmental contamination as discussed above, is largely invisible to the human eye. Contamination may also occur at a macro scale in the form of industrial accidents. Small numbers of Double-crested

Cormorants on the Pacific coast have been found dead during oil spills (Moffitt and Orr 1938; Straughan 1971; Smail et al. 1972, as cited in Carter et al. 1995; and Wilson et al. 1995). While an unknown number of Double-crested Cormorants most likely perished during the Nestucca oil spill of 1989, no statistics on species and number affected were available.

8.9 Disease

The spread of avian diseases, especially in the crowded conditions of colonial nesting birds, is a limiting factor that should not be overlooked when considering causes of change in population size. Avian disease may be manifested in either acute outbreaks that result in large numbers of dead or debilitated birds, or it may persist at lower levels in a chronic form and show up when birds become stressed due to other factors. Mass deaths are very visible and are usually reported. In South Africa, 14,500 Cape Cormorants (*Phalacrocorax capensis*) died in one season due to an outbreak of avian cholera (*Pasteurella multocida*) (Crawford et al. 1992). In Canada, an outbreak of Newcastle Disease in 1990 in Alberta, Saskatchewan and Manitoba was thought to have killed up to 10,000 Double-crested Cormorants (Bollinger 1994). The disease showed up again in 1992 over an increased range, including the Great Lakes and the American Midwest. In 1993, by measuring for maternal antibodies in egg samples, Bollinger (1994) found evidence of Newcastle Disease exposure at 19 out of 20 colonies sampled across Canada, including two colonies from British Columbia: Great Chain Island and Five Fingers Island.

8.10 Other Causes

On 26 Sept 1991, at Hudson Rocks, Moul (1991) observed a Pelagic Cormorant chick trapped on a nest, firmly entangled in monofilament fishing line. The line had wrapped around its neck and one wing and several times around a leg. Because the foot was gangrenous and the bird severely emaciated, it was destroyed. Vojkovich et al. (1989), as cited in Carter et al. (1995), implicated entanglement in fishnets and subsequent drowning as a factor in cormorant survival in California.

9. SPECIAL SIGNIFICANCE OF THE SPECIES

9.1 Status

The Double-crested Cormorant is a candidate for Threatened status in British Columbia because it is ranked S2 and is thus Red-listed by the B.C. Conservation Data Centre (CDC 2002). In Fraser et al. (1999), the Double-crested Cormorant is noted for having both few breeding colonies and low breeding success at those sites. In Washington State, the species is ranked S5 (demonstrably secure; NatureServe 2002).

9.2 Degree of Public Interest

Double-crested Cormorants are of significant public interest because of their large size and conspicuous habits. In British Columbia and in the San Juan Islands, bird watching, whale watching and kayak tours frequently pass close to nesting cormorants (Geisbrecht 2001). In contrast, over most other regions of North America, the Double-crested Cormorant is considered a pest and a liability to fish farming interests (Mott and Boyd 1995; Glahn et al. 2000).

9.3 Related Species

Five other cormorant species are found in North America: Great, Pelagic, Brandt's, Red-faced and Olivaceous or Neotropic. Only Brandt's and Pelagic cormorants occur in any abundance in British Columbia. The Double-crested Cormorant is most closely related to the Neotropic Cormorant (Hatch and Weseloh 1999).

10. RECOMMENDATIONS AND MANAGEMENT OPTIONS

In many other areas of North America, population levels of Double-crested Cormorants have increased so dramatically that efforts are being made to manage and control breeding and wintering populations (Glahn and Stickley 1995; Krohn et al. 1995; Milton et al. 1995; Mott and Boyd 1995; Glahn et al. 2000). Keith (1995) noted that increases in central and eastern Canada have led to pressures for control, which provinces have responded to in different ways. In

Manitoba, fishermen are illegally killing thousands of cormorants each year. Quebec is regulating a cull of breeding birds to protect island habitat. New Brunswick and Prince Edward Island have hunting seasons. Nova Scotia and Newfoundland give kill permits to individual fisherman. Conversely, the decline in the British Columbian population of Double-crested Cormorant (ssp. *albociliatus*) is a concern and requires a conservation and protection-driven approach.

10.1 Habitat Protection and Acquisition

The need for habitat protection for Double-crested Cormorants includes the sites of nesting colonies, roosting areas and foraging areas. While many of the recommendations below are specific to the breeding season, all can equally apply year-round for roost sites and foraging areas in proximity to colonies and roost sites.

10.1.1 Buffer zones

Restricting human access to cormorant colonies during the breeding season is most important. Buffer zones within which human activity and disturbance is restricted should be established around all existing nesting colonies and on potential colony sites, including most of the small rocky islets throughout the Strait of Georgia. Because Double-crested Cormorant colonies are usually situated on either small rocky islands or marine structures such as navigation aids, the delineation of buffer zones could be included on marine charts. In response to the U.S. *Endangered Species Act*, kayakers and other boaters were asked to stay 100 yards away from wildlife (Amato 1995). Members of the Whale Watch Operators Association Northwest request at least 50 m buffer zone around seabird rookeries (Obee 1998). In an article directed to pleasure boaters, Kondo (1999) promotes an April to mid-August time frame for a buffer zone of 100 m around all small islets. The most effective size of a buffer zone is a challenge that deserves further research. While larger buffer zones are better for the birds, it is important to select a buffer zone that maximises protection of the birds yet is not so large that boaters do not respect it.

10.1.2 Barriers to disturbance

When cormorants nest on larger islands such as at Mitlenatch Island Nature Park, complete isolation from persons landing on shore is likely not possible. It is recommended that, during the breeding season, all sites of nesting cormorants be completely out of bounds to park visitors. In situations where a bird blind might provide access for observing cormorant nests, a zone of complete invisibility from the colony would be required for those travelling to and from a blind. It is recommended that if such a blind is constructed, it should be at least 50 m from the perimeter of the colony. When research activities at cormorant colonies are proposed, it is recommended that those government and university agencies approving the research be mindful of the potential impact on colony success.

10.1.3 Seasonal windows of activity

Cormorants nesting on artificial structures (such as the marine navigation aids marking the effluent outfall near the pulp mill at Crofton), in the absence of nesting gulls, appear to have consistent nest success (Moul 2000). It is recognised that these nesting birds represent a nuisance to those servicing the structures. It is recommended that wildlife officials communicate with the various agencies responsible for the artificial structures and work together to time service visits outside of the nesting season. Co-operation could lead to methods for the mitigation of problems such as cormorant excrement covering the solar panels needed to charge batteries for the navigation lights.

Recommendations made by Carney and Sydeman (1999) to avoid negative impacts to cormorants include: a) not entering colonies; b) visiting only during the late-nesting phases; and c) constructing blinds or observation posts at safe distances from colonies.

10.1.4 Establishment of protected areas

The majority of Double-crested Cormorant nesting colonies are found on a multitude of small rocky islets scattered throughout the Georgia Basin area (see section 4.4 and Table 1). Double-crested Cormorants share these islands with Pelagic Cormorants, American Black Oystercatchers (*Haematopus bachmani*),

Glaucous-winged Gulls and other species, all of which are extremely susceptible to disturbance by human activity. It is recommended that wildlife officials inventory these rocks and islets and make efforts to establish protected areas with appropriate buffer zones where recommended.

10.2 Habitat Enhancement

Nesting success records demonstrate consistent nesting success at colonies on artificial structures away from nesting gulls. It is recommended that in areas proximate to cormorant colonies, existing potential artificial nesting structures be inventoried and considered for modification to produce nest sites. Ideal artificial nest structures would provide platforms upon which nests could be built and be designed to make it difficult for eagles to land.

10.3 Stewardship

Volunteers are currently involved in the B.C. Coastal Waterbird Survey (Bird Studies Canada 2000). Inventory results will provide additional data on the distribution and abundance of Double-crested Cormorants throughout the year. Local residents in the vicinity of important cormorant colonies can be encouraged to report human encroachment or other disturbance that may negatively impact nesting cormorants.

Long-term use of roost trees in urban areas can result in tree damage and foul odours; this has become an issue with some private landowners along the Gorge Waters in Greater Victoria. It is recommended that wildlife officials assist in educating municipalities/private landowners regarding the importance of roost trees in urban areas and anything that can be done to reduce/clean up the guano and save the trees.

11. RESEARCH NEEDS

11.1 Population Monitoring

Long-term monitoring of coastal Double-crested Cormorant populations is an important component of any cormorant management strategy. The existing practice of counting nests assumed to have been active in a past season does not provide information on the dynamics and success of a colony. More detailed monitoring of individual nests (via carefully constructed blinds or from a distance with high-powered scopes) should be carried out to determine the success and failure rates at selected colony sites. Reports of new colonies should be investigated, and a periodic complete nest census should cover all known colony sites.

Similarly, the interior population at Stum Lake should be monitored annually during American White Pelican censuses. Priority should be placed on confirming the subspecies of Double-crested Cormorant breeding at Stum Lake because it would help to determine the origin of, and migratory pathways taken by, these birds. This could prove to be very important in predicting risk factors associated with the potential transfer of Newcastle's disease to B.C.s only pelican breeding colony. In addition, attempts should be made to investigate other possible interior breeding locations for Double-crested Cormorant.

11.2 Disturbance Monitoring

Because disturbance by Bald Eagles appears to be a key component limiting nesting success at many of the local cormorant colonies, further research is highly recommended. While Geisbrecht (2001) has demonstrated that the presence of boaters in proximity to nesting colonies seldom resulted in cormorants leaving their nests, she clearly noted the need for further examination of the apparent nervous "teetering" movements as boats approached the colony sites. Further research is needed to determine if "teetering" behaviour is detrimental to eggs or chicks and what buffer distance would be required for cormorants to retain a "relaxed" nest behaviour.

11.3 Contaminant Monitoring

Routine, periodic collections of samples by Environment Canada to track contaminants in the food chain should be encouraged. Nest observations of birds raising young at sampled nests would add strength to any correlation between nesting productivity and levels of contaminant residues.

11.4 Prey-Base Monitoring

Prey-based monitoring of the cormorant food supply remains the weakest link in the potential variables

effecting population fluctuations. Examination of the supply and quality of Double-crested Cormorant prey items has been carried out by Robertson (1971) and by Sullivan (1998). Because the bulk of the prey consumed by cormorants in the Georgia Basin area are non-commercial fish species, little effort has been made to track changes in the mix of fish species or their fluctuating abundance. Periodic sampling of the cormorant prey base would allow population biologists to either include or eliminate cormorant prey supply as a variable affecting population parameters.

11.5 Habitat Mapping and Identification of Potential Nest Sites

Mapping existing and potential Double-crested Cormorant nesting and roosting habitats and having this information available to regional planners is an important safeguard to lessen conflicts in the early stages of development proposals.

12. EVALUATION

12.1 General

The Double-crested Cormorant occurs year-round throughout coastal areas of British Columbia, with the largest concentrations in the Strait of Georgia and Juan de Fuca Strait. The resident subspecies in British Columbia coastal waters is *P.a. albociliatus* (Cannings 1998). The Alaskan breeding subspecies (*P.a. cincinatus*) may occur during winter (Cannings 1998). The subspecific placement of the small interior breeding population is not known; it may be *P.a. albociliatus* or possibly *P.a. auritus* (Cannings 1998). Populations have declined rapidly since they peaked in the mid-1980s. Colony-sites are extremely vulnerable to disturbance by Bald Eagles and humans. Declines in reproductive success due to gull and crow depredation of eggs and chicks following eagle or human disturbance have been noted at most colony sites.

If the Stum Lake colony is found to be *P.a. auritus*, Red-listing may be in order, based on its single occurrence in the province. However, for this status report, in the absence of definitive taxonomic information, we have included it with the coastal population.

12.2 Provincial Ranking

The Double-crested Cormorant is currently Red-listed in the province and is ranked by the B.C. Conservation Data Centre as G5 globally and S2B provincially (Conservation Data Centre 2002). The G ranking indicates the status of the Double-crested Cormorant in its entire range; G5 indicates that it is globally common and demonstrably secure under present conditions. The S2B rating refers to its breeding status within British Columbia and indicates that the species is imperilled because of rarity (typically 6-20 occurrences) and/or because of some factor making it vulnerable to extirpation or extinction. The SZN rating applies to non-breeding status (N) within the province. The "Z" indicates that it occurs in the province as a diffuse population that is difficult to map as discrete units.

Known occurrences: B (= 6-20 occurrences)
There are currently 10 known active colonies on the B.C. coast and one inland.

Abundance: B (= 1000-3000 individuals)
Based on numbers of active nests counted, there are currently 1204 known adult breeders on the coast plus 22 at Stum Lake. Including non-breeders and yearlings, the population is most likely less than 2000 individuals.

Range: B (narrow range, less than 10% of territory)
Double-crested Cormorants have a relatively narrow breeding range in British Columbia, restricted to a portion of the south coast and one location in the central interior.

Trend: A (= declining rapidly)
Trend is ranked based on recent (past 10 years) data. On the coast, numbers increased from 203 nests in 1959 to 1981 nests in 1987, but then declined just as abruptly to 602 active nests in the year 2000. Nest success has dropped to near zero at three of the historically largest colonies (Great Chain Island, Mandarte Island and Five Fingers Island) for the past five years (1996 to 2000).

Protected Occurrences: C (= several protected)
Protected sites known to have active breeding colonies now or in the recent past include: Oak Bay Islets Ecological Reserve (Great Chain Island), Christie Island Bird Sanctuary, Rose Islets Ecological Reserve, Trincomali Nature Sanctuary (Galiano Cliffs), Mitlenatch Island Nature Park and Stum Lake Provincial Park. However, none of these parks or reserves fully protects the foraging areas and food of these birds. Table 1 lists the current land title status of known current and historic colony sites.

Threats: A (= very threatened, species or community directly exploited or threatened by natural or human related forces)
The decline in nest success on Great Chain Island, Mandarte Island and Five Fingers Island is probably the result of ongoing disturbance by Bald Eagles and depredation by gulls and crows. While human disturbance has been documented, its level of impact compared to disturbance by Bald Eagles is not clearly understood.

Recommended Rank: S2B SZN
A "2" ranking for the breeding season indicates that the Double-crested Cormorant is imperilled provincially because of rarity (only 11 breeding colonies) and because disturbance and nest depredation are causing a serious decline, making it vulnerable to extirpation.

Summary of Provincial Ranking
The recent rapid declines in reproductive success and breeding population size are threatening the future viability of coastal breeding populations in British Columbia. It is recommended that the current Red List status of the species be maintained.

13. CONTACTS

Syd Cannings – Conservation Data Centre, Ministry of Sustainable Resource Management

Trudy Chatwin – Ministry of Water, Land and Air Protection

Myke Chutter – Ministry of Water, Land and Air Protection

Curt Kraemer – Washington State Fish and Wildlife

Ruth Millner – Washington State Fish and Wildlife

Ken Morgan – Canadian Wildlife Service

Dave Nyswinder – Washington State Fish and Wildlife

Julie Steciw – Ministry of Water, Land and Air Protection

Terry Sullivan – San Rafael Research Aviary

Ulrich Wilson – Washington State Fish and Wildlife

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Appendix 1. Historical records of Double-crested Cormorant colonies in British Columbia, 1927 to 2000.

Colony name	Locality	Year	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
Great Chain Island	Oak Bay	2000	95				Chatwin et al. 2001
Great Chain Island	Oak Bay	1999	100	100	0		Moul 2000
Great Chain Island	Oak Bay	1998	300	300	0		Moul 2000
Great Chain Island	Oak Bay	1995	432	432	0		Moul 1995
Great Chain Island	Oak Bay	1994	444				Moul 1994
Great Chain Island	Oak Bay	1993	339				Moul 1993
Great Chain Island	Oak Bay	1990	686				Breault 1990
Great Chain Island	Oak Bay	1987	510				Vermeer et al. 1989
Great Chain Island	Oak Bay	1983	135				Vermeer and Rankin 1984
Great Chain Island	Oak Bay	1974	0				Campbell 1976
Great Chain Island	Oak Bay	1959	0				Drent and Guiguet 1961
Mandarte Island	Sidney	2000	215				Chatwin et al. 2001
Mandarte Island	Sidney	1999	43	43	0	0	Moul 2000
Mandarte Island	Sidney	1998	178	178	0	0	Moul 2000
Mandarte Island	Sidney	1995	288	288	80		Moul 1995
Mandarte Island	Sidney	1994	403	403	2	6	Sullivan 1998
Mandarte Island	Sidney	1993	458	458	366	1189	Sullivan 1998
Mandarte Island	Sidney	1992	280	101	56	127	Moul 1992
Mandarte Island	Sidney	1990	473				Breault 1990
Mandarte Island	Sidney	1987	972				Vermeer et al. 1989
Mandarte Island	Sidney	1983	1100				Vermeer and Rankin 1984
Mandarte Island	Sidney	1974	482				Campbell 1976
Mandarte Island	Sidney	1960	135				Drent and Guiguet 1961
Mandarte Island	Sidney	1959	150				Drent and Guiguet 1961
Mandarte Island	Sidney	1958	150				Drent and Guiguet 1961
Mandarte Island	Sidney	1957	150				Drent and Guiguet 1961
Mandarte Island	Sidney	1953	145				Drent and Guiguet 1961
Mandarte Island	Sidney	1945	23				Drent and Guiguet 1961
Mandarte Island	Sidney	1942	17				Drent and Guiguet 1961
Mandarte Island	Sidney	1935	5				Drent et al. 1964
Mandarte Island	Sidney	1927	3				Munro 1928

Appendix 1. continued.

Colony name	Locality	Year	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
Ballingal Island	Galiano Island	2000	0				Chatwin et al. 2001
Ballingal Island	Galiano Island	1987	25				Vermeer et al. 1989
Ballingal Island	Galiano Island	1983	20				Vermeer and Rankin 1984
Ballingal Island	Galiano Island	1974	14				Campbell 1976
Ballingal Island	Galiano Island	1959	28				Drent and Guiguet 1961
Ballingal Island	Galiano Island	1957	74				Drent and Guiguet 1961
Ballingal Island	Galiano Island	1944	44				Drent and Guiguet 1961
Ballingal Island	Galiano Island	1941	36				Drent and Guiguet 1961
Ballingal Island	Galiano Island	1939	33	33	28	68	Drent and Guiguet 1961
Ballingal Island	Galiano Island	1936	23				Drent and Guiguet 1961
Ballingal Island	Galiano Island	1933	1				Drent and Guiguet 1961
Rose Islets	Thetis Island	2000	15				Chatwin et al. 2001
Rose Islets	Thetis Island	1999	6				Moul 2000
Rose Islets	Thetis Island	1999	6				Moul 2000
Rose Islets	Thetis Island	1987	2				Vermeer et al. 1989
Rose Islets	Thetis Island	1983	12				Vermeer and Rankin 1984
Rose Islets	Thetis Island	1974	80				Campbell 1976
Rose Islets	Thetis Island	1959	0				Drent and Guiguet 1961
Channel Islands	Saltspring Island	2000	0				Chatwin et al. 2001
Channel Islands	Saltspring Island	1987	0				Vermeer et al. 1989
Channel Islands	Saltspring Island	1983	0				Vermeer and Rankin 1984
Channel Islands	Saltspring Island	1974	0				Campbell 1976
Channel Islands	Saltspring Island	1959	16				Drent and Guiguet 1961
Channel Islands	Saltspring Island	1952	1				Drent and Guiguet 1961
Galiano cliffs	Galiano Island	2000	14				Chatwin et al. 2001
Canoe Island	Valdes Island	2000	0				Chatwin et al. 2001
Canoe Island	Valdes Island	1987	0				Vermeer et al. 1989
Canoe Island	Valdes Island	1983	0				Vermeer and Rankin 1984
Canoe Island	Valdes Island	1974	12				Campbell 1976
Canoe Island	Valdes Island	1959	0				Drent and Guiguet 1961
Second Sister Island	Saltspring Island	1987	0				Vermeer et al. 1989
Second Sister Island	Saltspring Island	1983	0				Vermeer and Rankin 1984

Appendix 1. continued.

Colony name	Locality	Year	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
Second Sister Island	Saltspring Island	1974	0				Campbell 1976
Second Sister Island	Saltspring Island	1960	4				Drent and Guiguet 1961
Second Sister Island	Saltspring Island	1959	9				Drent and Guiguet 1961
Second Sister Island	Saltspring Island	1957	1				Drent and Guiguet 1961
Second Sister Island	Saltspring Island	1956	1				Drent and Guiguet 1961
Annette Inlet	Prevost Island	1988	25				Carter et al. 1995
Charles Island	Galiano Island	1954	6				Clay and Davidson 1954
Shoal Island	Crofton	2000	104				Chatwin et al. 2001
Shoal Island	Crofton	1999	83	83	58	165	Moul 2000
Shoal Island	Crofton	1995	71				Moul 1995
Shoal Island	Crofton	1994	75				Moul 1994
Shoal Island	Crofton	1993	74				Moul 1993
Shoal Island	Crofton	1992	74	74	71	181	Moul 1992
Shoal Island	Crofton	1991	78	78	38	91	Moul 1991
Shoal Island	Crofton	1990	44				Breault 1990
Shoal Island	Crofton	1987	65				Vermeer et al. 1989
Bare Point	Chemainus	2000	0				Chatwin et al. 2001
Bare Point	Chemainus	1999	11				Moul 2000
Bare Point	Chemainus	1998	19				Moul 2000
Bare Point	Chemanus	1996	23				Moul 1996
Bare Point	Chemainus	1990	18				Breault 1990
Bare Point	Chemainus	1987	0				Vermeer et al. 1989
Bare Point	Chemainus	1983	198				Vermeer and Rankin 1984
Bare Point	Chemainus	1974	0				Campbell 1976
Bare Point	Chemainus	1959	0				Drent and Guiguet 1961
Hudson Rocks	Nanaimo	2000	0				Chatwin et al. 2001
Hudson Rocks	Nanaimo	1999	0				Moul 2000
Hudson Rocks	Nanaimo	1998	0				Moul 2000
Hudson Rocks	Nanaimo	1995	15	15	0		Moul 1995
Hudson Rocks	Nanaimo	1994	16				Moul 1994
Hudson Rocks	Nanaimo	1993	25				Moul 1993
Hudson Rocks	Nanaimo	1992	30	30	0		Moul 1992

Appendix 1. continued.

Colony name	Locality	Year	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
Hudson Rocks	Nanaimo	1991	67	54	54	131	Moul 1991
Hudson Rocks	Nanaimo	1987	17				Vermeer et al. 1989
Hudson Rocks	Nanaimo	1983	0				Vermeer and Rankin 1984
Hudson Rocks	Nanaimo	1974	0				Campbell 1976
Hudson Rocks	Nanaimo	1959	0				Drent and Guiguet 1961
Five Fingers Island	Nanaimo	2000	0				Chatwin et al. 2001
Five Fingers Island	Nanaimo	1999	42				Moul 2000
Five Fingers Island	Nanaimo	1998	43	43	0		Moul 2000
Five Fingers Island	Nanaimo	1995	295	295	0		Moul 1995
Five Fingers Island	Nanaimo	1994	378	378	307	945	Sullivan 1998
Five Fingers Island	Nanaimo	1993	306	306	264	842	Sullivan 1998
Five Fingers Island	Nanaimo	1992	191	26	24	72	Moul 1992
Five Fingers Island	Nanaimo	1991	118	47	45	115	Moul 1991
Five Fingers Island	Nanaimo	1990	153				Breault 1990
Five Fingers Island	Nanaimo	1987	138				Vermeer et al. 1989
Five Fingers Island	Nanaimo	1983	0				Vermeer and Rankin 1984
Five Fingers Island	Nanaimo	1974	0				Campbell 1976
Five Fingers Island	Nanaimo	1959	0				Drent and Guiguet 1961
Mitlenatch Island	Cortes Island	2000	70				Chatwin et al. 2001
Mitlenatch Island	Cortes Island	1999	47				Moul 2000
Mitlenatch Island	Cortes Island	1998	46				Moul 2000
Mitlenatch Island	Cortes Island	1995	43				Moul 1999
Mitlenatch Island	Cortes Island	1994	33				Moul 1994
Mitlenatch Island	Cortes Island	1993	10				Moul 1993
Mitlenatch Island	Cortes Island	1992	0				Moul 1992
Sand Heads	Fraser Delta	2000	35				Chatwin et al. 2001
Sand Heads	Fraser Delta	1987	86				Vermeer et al. 1989
Westshore Terminal	Tsawwassen	2000	11				Chatwin et al. 2001
Westshore Terminal	Tsawwassen	1994	26	26	21	55	Sullivan 1998
Westshore Terminal	Tsawwassen	1993	52	52	40	86	Sullivan 1998
Westshore Terminal	Tsawwassen	1987	42				Vermeer et al. 1989
Queen's Reach	Fraser River	1983	1				

Appendix 1. continued.

Colony name	Locality	Year	Active nests	Sample of active nests	Successful nests	Number of chicks	Source
McRae Islets	Powell River	2000	1				Chatwin et al. 2001
McRae Islets	Powell River	1995	0				Moul 1995
Christie Island	Howe Sound	2000	42				Chatwin et al. 2001
Christie Island	Howe Sound	1987	119				Vermeer at al. 1989
Christie Island	Howe Sound	1985	82				Sullivan 1985
Christie Island	Howe Sound	1983	164				Sullivan 1985
Christie Island	Howe Sound	1983	120				Vermeer and Rankin 1984
Christie Island	Howe Sound	1981	169				Sullivan 1985
Christie Island	Howe Sound	1980	136				Sullivan 1985
Christie Island	Howe Sound	1979	94				Sullivan 1985
Christie Island	Howe Sound	1977	61				Sullivan 1985
Christie Island	Howe Sound	1976	79				Sullivan 1985
Christie Island	Howe Sound	1974	29				Campbell 1976
Christie Island	Howe Sound	1973	1				Sullivan 1985
Christie Island	Howe Sound	1971	1				Sullivan 1985
Christie Island	Howe Sound	1970	3				Sullivan 1985
Christie Island	Howe Sound	1963	1				Sullivan 1985
Christie Island	Howe Sound	1941	1				Drent and Guiguet 1961
Merry Island	Sechelt	2000	0				Chatwin et al. 2001
Merry Island	Sechelt	1987	5				Vermeer et al. 1989
Merry Island	Sechelt	1983	21				Vermeer and Rankin 1984
Merry Island	Sechelt	1974	54				Campbell 1976
Merry Island	Sechelt	1959	0				Drent and Guiguet 1961
Stum Lake	Inland B.C.	2000	11				MELP (unpub. data)
Stum Lake	Inland B.C.	1999	10				MELP (unpub. data)
Stum Lake	Inland B.C.	1998	9				MELP (unpub. data)
Stum Lake	Inland B.C.	1997	7				MELP (unpub. data)
Stum Lake	Inland B.C.	1996	7				MELP (unpub. data)
Stum Lake	Inland B.C.	1995	5				MELP (unpub. data)
Stum Lake	Inland B.C.	1994	6				MELP (unpub. data)
Stum Lake	Inland B.C.	1993	4				MELP (unpub. data)